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(54) **Air pumps**

(57) An air pump constructed of a lever pivotally connected to a base with an air-pressure actuator located there between. Movement of the lever produces pressurized air in the actuator to be supplied to an inflatable object, such as an automobile tire. The actuator and the lever are pivotally mounted to the base. A relief valve apparatus 10' is connected to the actuator to prevent the actuator from exceeding a preselected pressure level. The relief valve apparatus includes an adjustable relief and a check valve 154' normally seated preventing conducting of pressurized air from the actuator. The relief valve can be isolated from pressure surges produced in the actuator by a diaphragm valve 204 so that the valve only responds to the pressure level existing in said inflatable object.

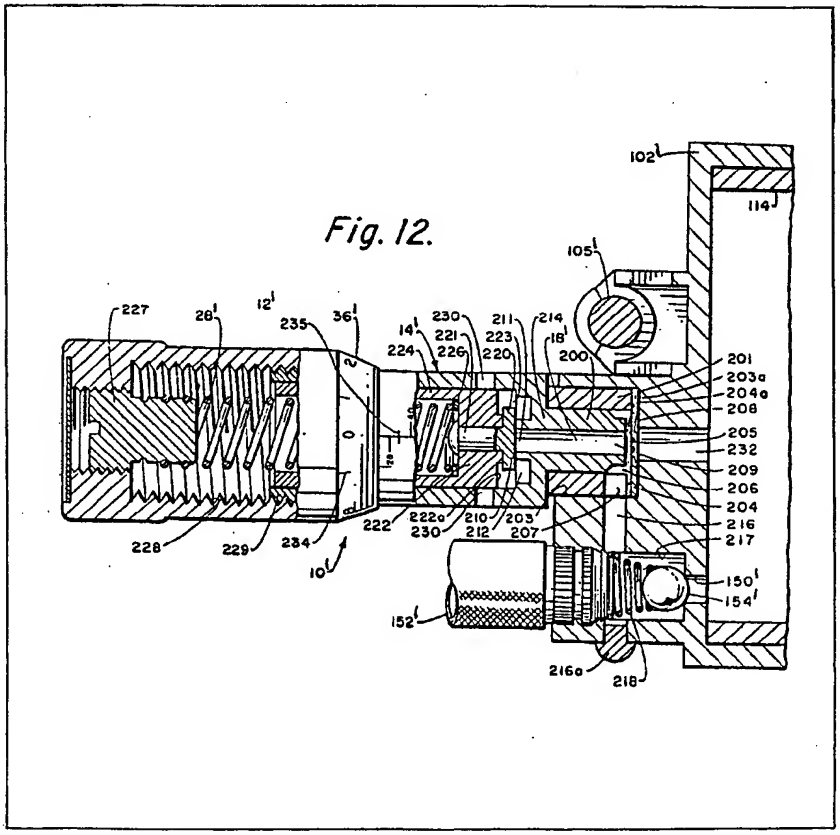

Fig. 12.

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Fig. 1.

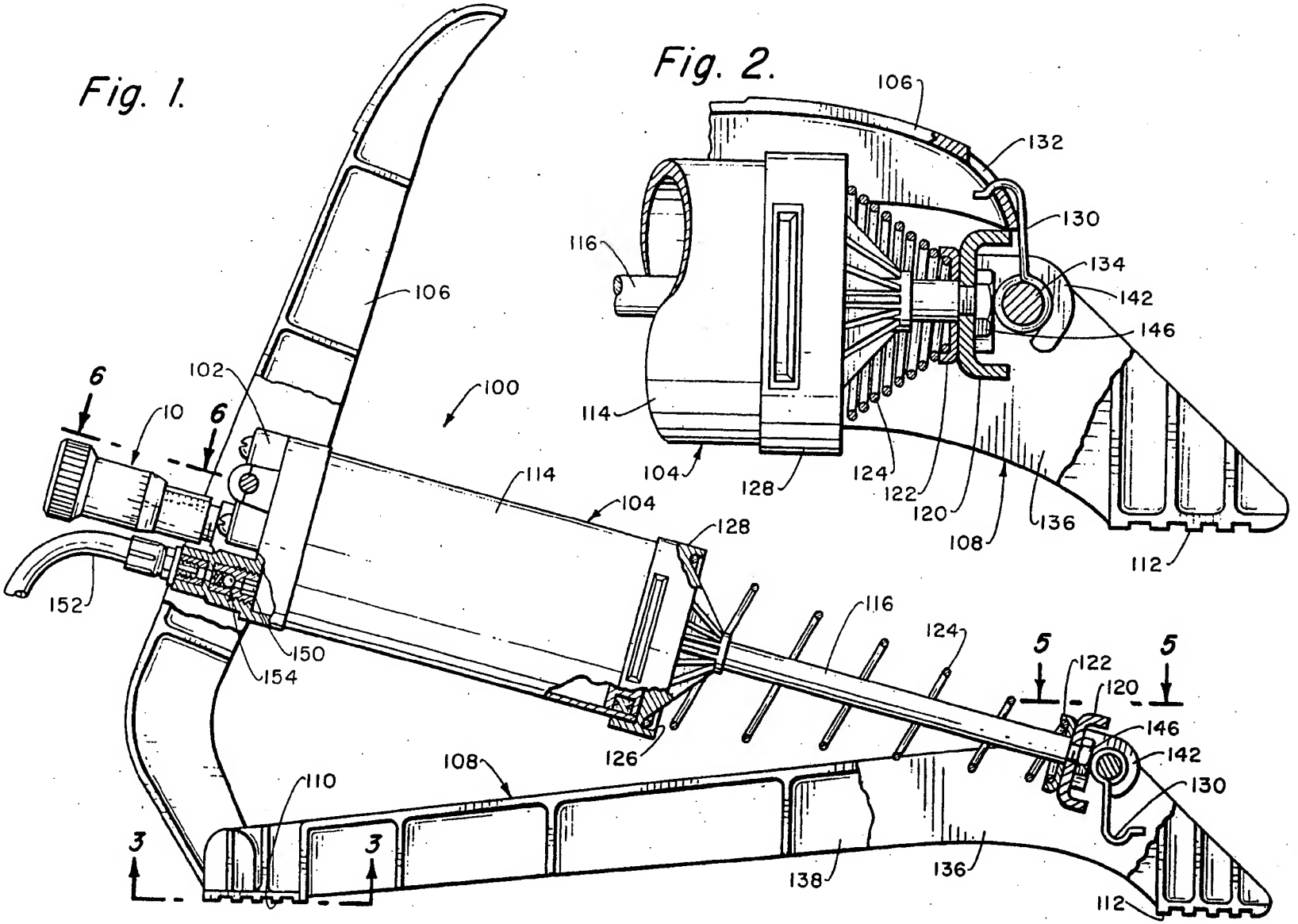

Fig. 2.

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Fig. 3.

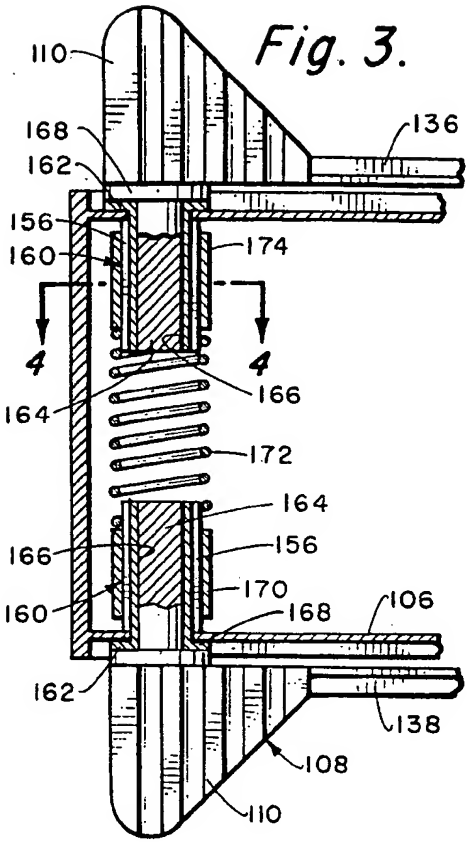


Fig. 4.

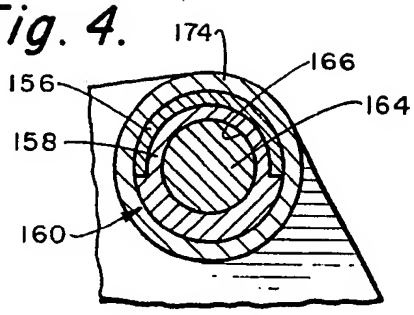


Fig. 5.

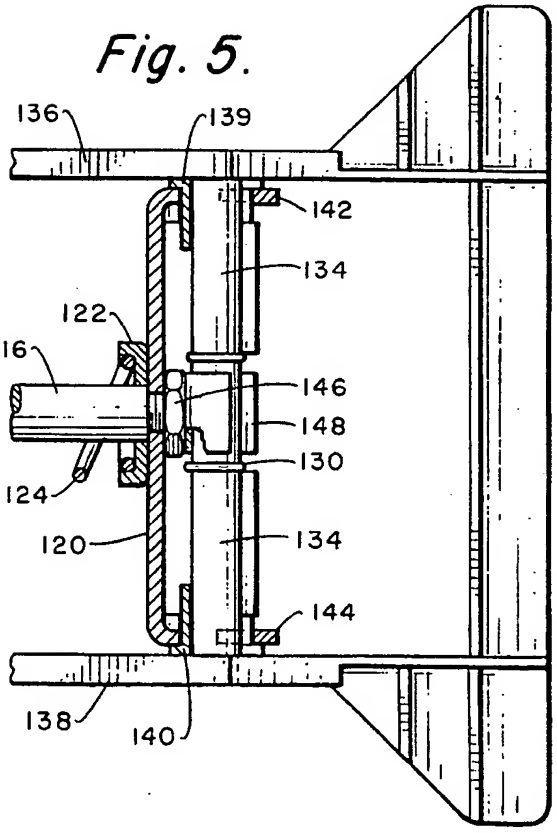


Fig. 9.

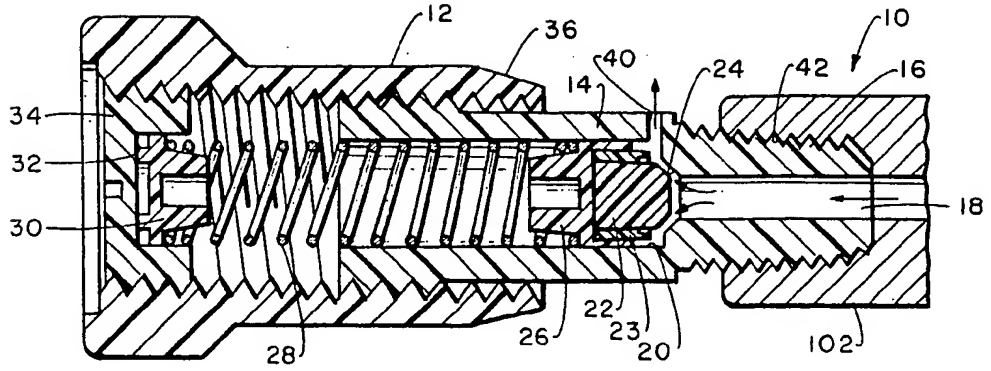


Fig. 6.

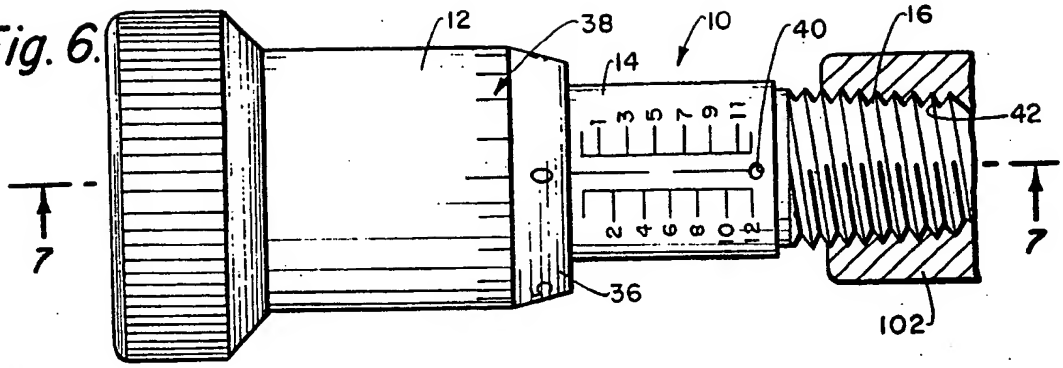


Fig. 7.

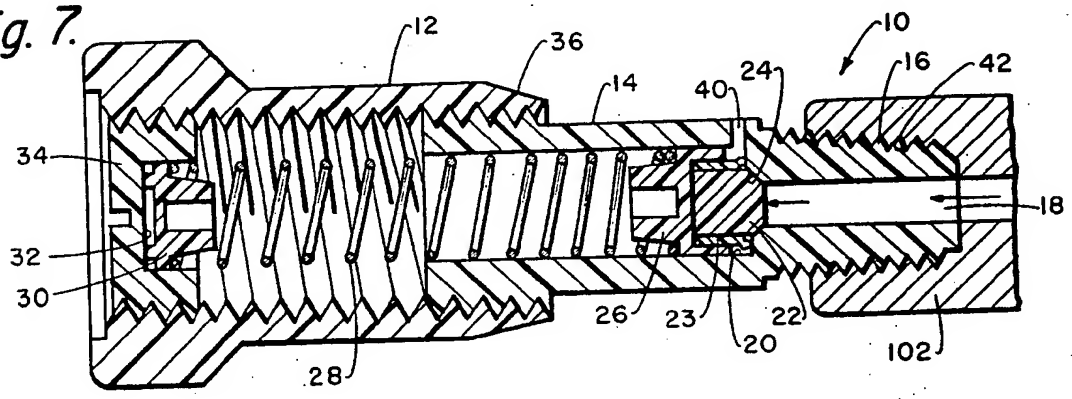


Fig. 8.

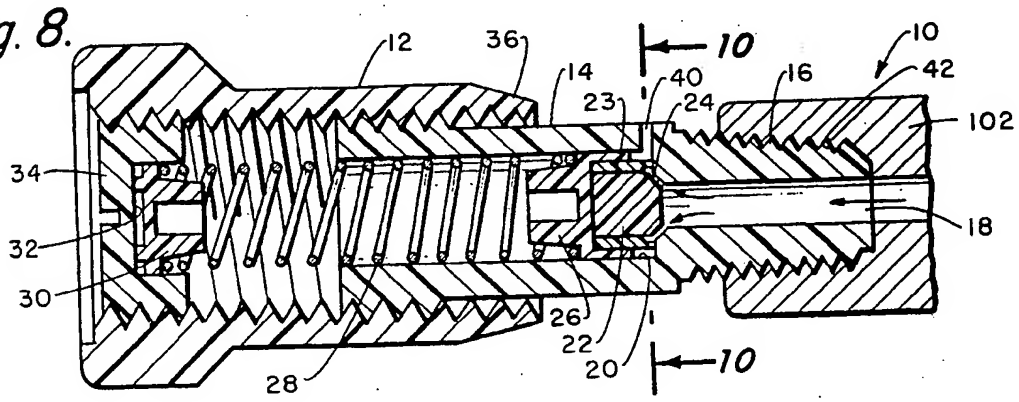
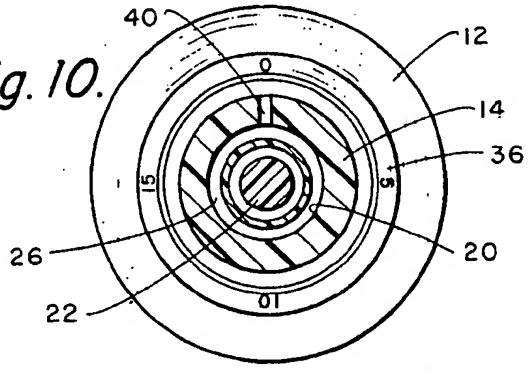


Fig. 10.



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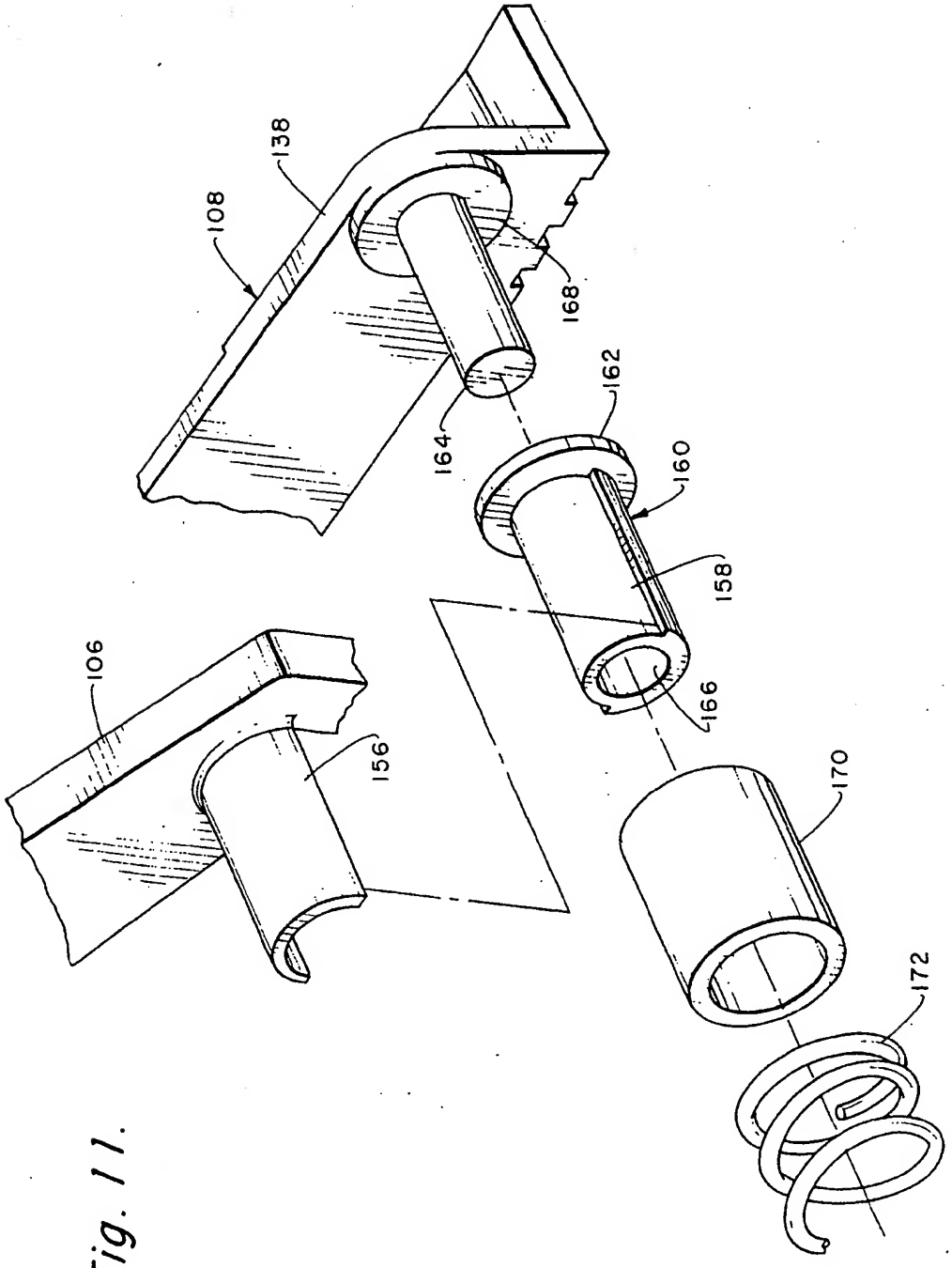


Fig. 11.

Fig. 12.

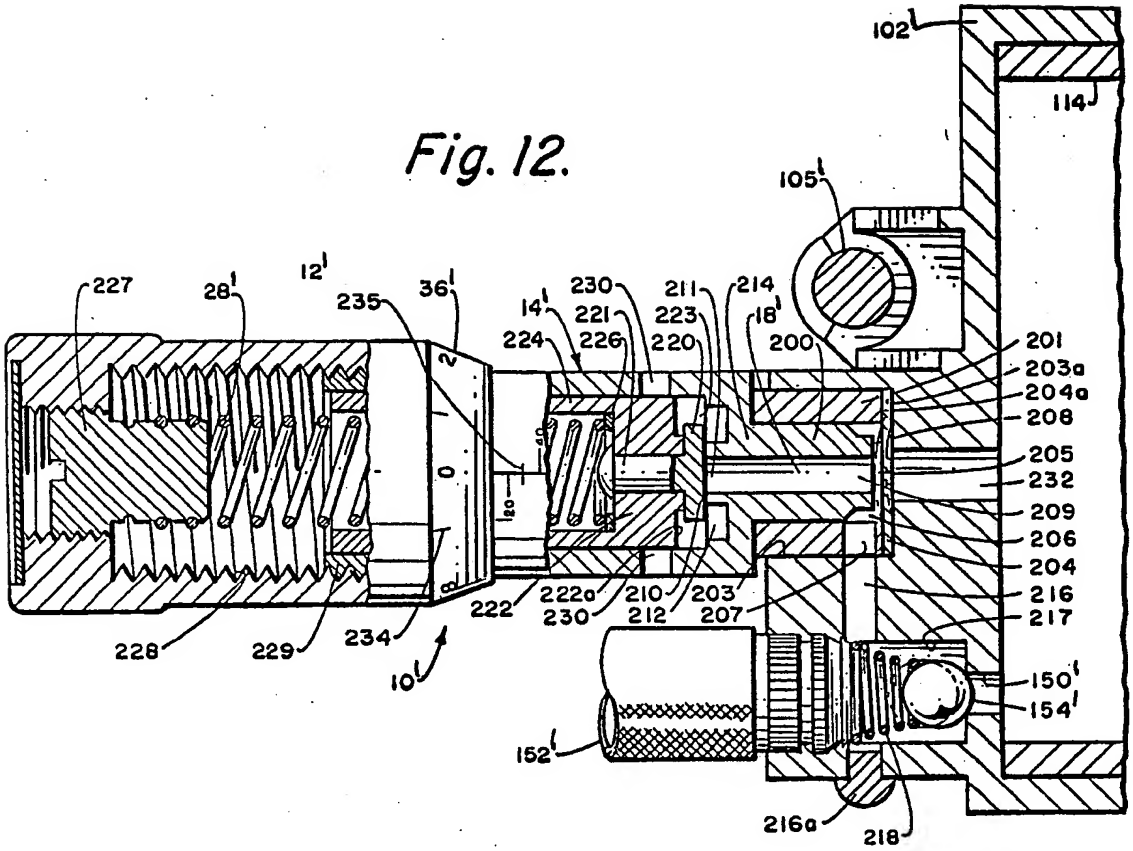
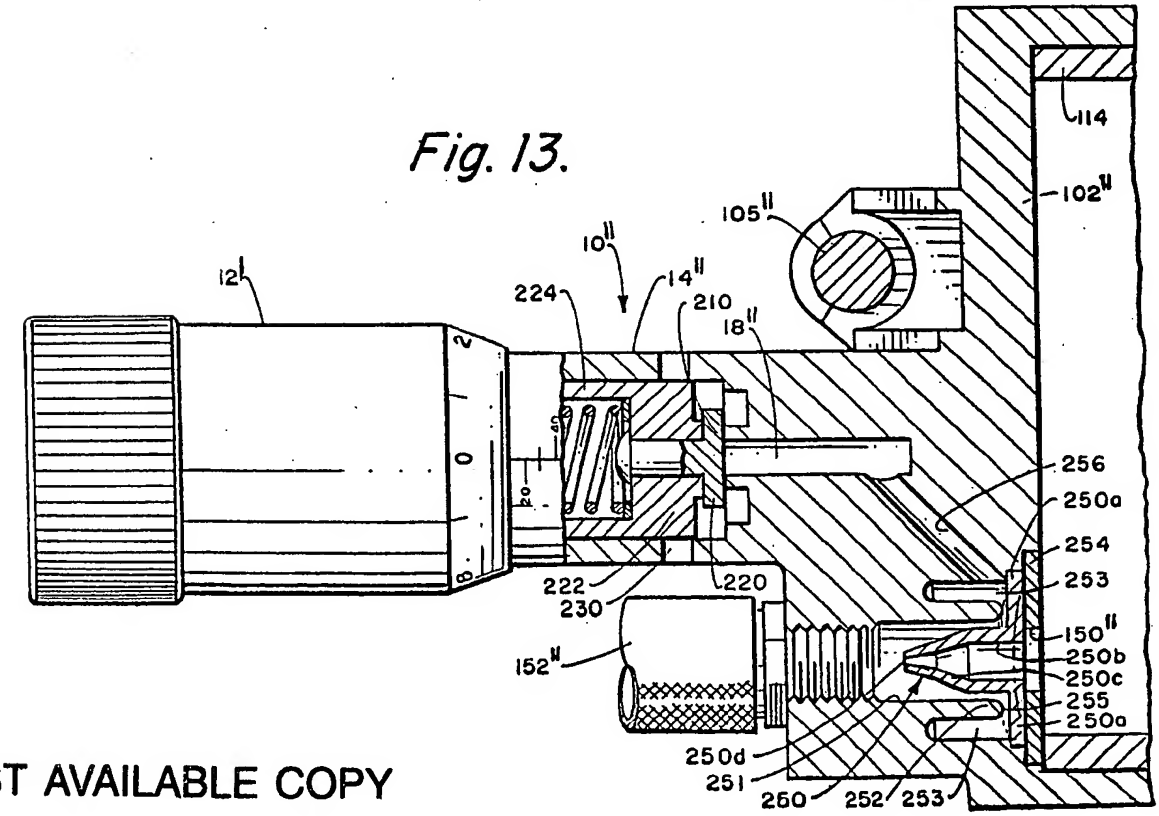


Fig. 13.



SPECIFICATION

Air pump

Technical field

The field of this invention relates to a pump for the producing of pressurized air for the inflating of pneumatic objects, such as vehicle tires. The field of this invention also relates to a relief valve which is preselectable to various selected pressure levels to thereby, upon activation of the air pump, avoid any possibility of overinflation of the pneumatic device.

Background of the prior art

In the pressurizing of automobile tires and the like, there are instances when it is necessary to inflate the tire by a manual pump. The pumps that are frequently employed of this type are normally activated by a reciprocating action by either the person's hand or feet. Such prior pumps have been constructed of inferior materials in an effort to hold down manufacturing costs. Also, the assemblage techniques of such pumps have not been extremely efficient. As a result, the overall manufacturing cost is not as low as it could be and the quality of construction of such prior pumps are not at the desired level.

Frequently, the prior pumps include some type of pressure gauge to indicate to the operator the level of the pressure within the inflating device. In the past, the type of pressure gauge that has been employed has been a dial moved by a bourdon tube. This type of instrument is readily susceptible to damage and is also quite expensive to manufacture.

Brief summary of the invention

The air pump of this invention provides for a lever which is hingedly connected to a base. The connection between the lever and the base is simply accomplished through the use of a bushing assembly. Upon the bushing assembly is located a retainer ring assembly which is spring biased to a position to continuously maintain the pivotal interconnection between the lever and the base. An air pressure producing actuator is pivotally connected between the lever and the free end of the base. The actuator basically comprises a conventional piston and cylinder plus a spring assembly to exert a continuous bias tending to maintain the piston rod in the extended position.

Included within the air pump of this invention is a relief valve assembly which employs a pair of members, an outer member and inner member, which are telescopingly interconnected together through a screw-threaded arrangement. The inner member, which can be called the body, includes an air passage therein which connects with an air receiving chamber located within the body. A relief passage is formed within the body and connects with the air receiving chamber. The air receiving chamber is normally closed by means of a valve assembly which, in turn, connects with a spring and it is therefore under constant bias to maintain the valve in the closed position preventing passage of air from the air passage to the air receiving chamber. In one form, the valve assembly includes an inner valve member and an outer valve member and upon initial unseating of the inner valve member, the air pressure is exposed to a substantially greater area which "snaps" the entire valve assembly against the bias of the spring. This permits air pressure from the air passage to be conducted through the relief passage to the ambient. The free end of the spring is connected to a spring retainer which is fixedly mounted within the outer member. The outer member is threadingly movable upon the body and as the outer member is screwed down upon the body, the bias of the spring increases which therefore requires a greater amount of pressure to unseat the valve. Appropriate indicia is located on both the outer member and the body and based on position of one with respect to the other, a preselected value of gas pressure will be required to unseat the valve. Therefore, the automobile tire or other inflatable object can be inflated to a predetermined pressure without fear of overinflation by merely presetting the relief valve prior to initiating the inflation procedure.

In other forms of the relief valve, the valve assembly includes a movable valve member located at the closed end of a cylindrical member slidably located within the valve body. A spring biases the cylindrical member and valve member towards a fixed valve seat at the termination of the air passage within the body. The valve member is smaller than the closed end of the cylindrical member and the air receiving chamber is located around the circumference of the valve member. The side of the cylindrical member normally covers a passage in the body leading to ambient pressure. This structure also provides an air conduit leading from the downstream side of the check valve to the air passage in the body through a membrane type valve which is closed when acted upon by pressurized air leaving the actuator so that the relief valve does not respond to high pressure pulses produced by the actuator. When the check valve is closed and high pressure surges are not being produced by the actuator, the membrane valve is acted upon by the true pressure in the inflatable object to open the diaphragm valve and subject the relief valve to the true pressure in the inflatable object. The membrane valve can take several forms which function in the same way. The movement of the valve member exposes the greater area of the closed end of the cylinder in order to obtain a "snap" action against the spring.

One of the primary objectives of the air pump of this invention is to construct the air pump of few parts to therefore minimize manufacturing expense.

Another objective of this invention is to construct the air pump of few parts which can be easily assembled by unskilled labor.

A further objective of this invention is that the air pump can be readily adjusted to preselected precise values of pressure prior to inflation of the inflatable object.

A further objective is to provide a pressure relief valve which senses the pressure within the inflatable object and is not subject to higher pressures developed during the pumping action.

Brief description of the drawings

Figure 1 is a side view of the air pump of this invention which has been partially broken away in sections in order to observe pertinent features of this invention;

Figure 2 is an enlarged view of a portion of the air pump of this invention depicting the closed position of the air pump to facilitate storage;

Figure 3 is a bottom view of the hinge connection between the lever and the base of the air pump of this invention taken along line 3-3 of Figure 1;

Figure 4 is a cross-sectional view taken along line 4-4 of Figure 3;

Figure 5 is a top view of the hinge connection between the actuator assembly and the base taken along line 5-5 of Figure 1;

Figure 6 is an elevational view of the relief valve assembly incorporated within the air pump of this invention;

Figure 7 is a cross-sectional view taken along line 7-7 of Figure 6;

Figure 8 is a cross-sectional view similar to Figure 7 but showing the valve assembly in the initial opening position;

Figure 9 is a view similar to Figure 8 but showing the valve assembly in the completely open position;

Figure 10 is a cross-sectional view taken along line 10-10 of Figure 8;

Figure 11 is an exploded isometric view of the hinge connection between the lever and the base;

Figure 12 is a sectional view of a modified relief valve which is protected from high pressure pulses produced by the actuator; and

Figure 13 is a sectional view of another modification of a relief valve which is protected from high pressure pulses produced by the actuator.

Detailed description of the invention

Referring particularly to the drawings, there is shown the air pump 100 of this invention which is composed primarily of a lever 106, a base 108 and an actuator 104. Both the lever 106 and base 108 are constructed of a rigid material, such as aluminum or the like. The bottom surfaces 110 and 112 of the base 108 are constructed so as to facilitate grabbing of the base 108 when it is supported upon a surface. This is to prevent undesired movement of the air pump when it is used.

The actuator 104 employs a conventional cylinder 114 within which is movably contained a piston 103. The cylinder 114 is closed at one end by cover 102. Cover 102 is pivotally mounted by rod 105 to lever 106. The piston is connected to a piston rod 116 which extends exteriorly of the cylinder 114 and is fixedly connected to a bridge plate 120. Mounted next to the bridge plate 120 about the rod 116 is a spring retainer cap 122. A coil spring 124 is located about the piston rod 116 and is in contact with the cap 122. The opposite end of the coil spring 124 is positioned within annular groove 126 of a cap 128 which is fixedly mounted upon the cylinder 114. The coil spring 124 functions to exert a continuous bias tending to completely extend the piston rod 116 which would place the piston 103 in the "bottomed out" position within the cylinder 114. With the actuator assembly 104 fully compressed, the coil spring 124 is also fully compressed to the position shown in Figure 2 of the drawings. As will be explained further on in the specification, this position is the normally stowed position for the air pump of this invention since it is most compact in this position. This position is maintained, when desired, by means of a locking clip 130. The locking clip 130 has a hook end which cooperates within an opening 132 formed within the lever 106. The locking clip 130 is pivotally mounted upon a pin 134. The pin 134 is fixedly secured between the spaced apart side members 136 and 138 of the base 108. The side members 136 and 138 are interconnected together through feet sections 110 and 112.

Located about one end of the pin 134 is a first bushing 139 with a second bushing 140 located about the other end of the pin 134. The second bushing 140 is in contact with side member 138 with the first bushing 139 in contact with the side member 136. The bridge plate 120 includes a pair of hook-shaped members 142 and 144. Member 142 surrounds the bushing 138 slightly over one hundred and eighty degrees so as to therefore remain in position about the bushing 138. Similarly, the hook member 144 surrounds the bushing 140. The nut 146 which secures the piston rod 116 to the bridge plate 120 is positioned substantially adjacent to a bushing 148 which is rotatably mounted upon the pin 134. It is to be understood from the foregoing that the piston rod 116 is capable of pivoting movement with respect to the rod 134. This pivoting movement is necessary due to the operation of the air pump 100.

Within the cover 102 is an air outlet passage 150 which is to permit air to be conducted exteriorly of the cyliner 114 to conduit 152. It is to be understood that conduit 152 will connect through an appropriate fitting to a pneumatic device, such as a tire. Within the conduit 150 is to be located a conventional one-way check valve assembly 154.

Screw threadingly received within the cover 102 is a relief valve assembly 10. This relief valve assembly will be described in more detail further on in the specification.

The interconnection of the lever 106 to the base 108 to facilitate pivoting motion therebetween is accomplished through a segment of a cylinder 156 being integrally formed upon the lever 106. This segment of cylinder 156 is to be located upon a mating recess 158 formed within a nylon bushing 160. The bushing 160 includes an enlarged annular head 162. A pin 164 is to establish a close but movable connection within the opening 166 of the bushing 160. The head 162 is to be located against boss 168 formed integrally upon side member 138.

With the pin 164 located within the opening 166 and the head 162 against the boss 168 and member 156 in place upon the bushing 160, a retainer ring 170 is to be placed over the member 156 and the bushing 160. This retainer ring 170 therefore forms a secure connection between the lever 106 and the side member 138 but yet permits pivoting of the lever 106 in respect to the side member 138. A coil spring 172 is in abutting contact with the retainer ring 170. It is to be understood that a connection similar to what has previously been described in

relation to the bushing 160, member 156 and pin 164 will be similarly constructed in relation to the side member 136. The free end of the spring 172 will also be in contact with retainer ring 174, therefore the spring 172 maintains the position of each of the retainer rings 170 and 174 and thereby fixes the interconnection between the lever 106 and the base 108.

Referring particularly to Figure 6 - 10 of the drawings, there is shown the relief valve assembly 10 incorporated in this invention which is composed primarily of an outer member or cap 12 and an inner member or body 14. The cap 12 is screw threadingly mounted upon the inner end of the body 14. The outer end of the body 14 includes a set of tapered threads 16. The treads 16 are to connect with the threaded opening 42 formed in cover 102 of pumping actuator 104.

Within the body 14 is formed an air or gas passage 18 which terminates into an air or gas receiving chamber 20. The chamber 20 is cross-section, as well as the passage 18, are circular. Movably mounted within the chamber 20 is a rubber or other slightly resilient type of valve member 22. The valve member 22 is capable of coming into flush contact with the valve seat 24 located about the inner end of the passage 18 and thereupon close the passage 18 and prevent air from passing from the passage 18 into the chamber 20. Surrounding member 22 is on other valve member 23. Members 22 and 23 are located in a close fitting relationship but permitting movement therebetween.

Also movably mounted within the chamber 20 and in a continuously abutting contact with the valve member 22 and member 23 is a first spring retainer 26. A portion of the retainer 26 surrounds a portion of the member 23 in a close-fitting relationship but permitting movement therebetween. The retainer 26 will normally be constructed of a rigid material, such as plastic. A coil spring 28 extends within the chamber 20 and connects with the spring retainer 26.

The free end of the coil spring 28 is located about a second spring retainer 30. The second spring retainer 30 fits within appropriate recess 32 formed wlthin a plug 34. The plug 34 is screw threaded in the outer end of the cap 12.

The end of the cap 12 located directly adjacent the body 14 is formed into a beveled surface 36. Upon the beveled surface 36 are located a first indicia in the form of the numerals zero, five, ten and fifteen, each of the numerals being located ninety degress apart. Also formed on the exterior surface of the cap 12 adjacent the beveled surface 36 are a plurality of graduations in the form of lines 38. It is to be noted that there are twenty in number of the lines 38 and the construction of the assembly 10 is such that if the cap 12 is rotated the distance of one graduation line to the next graduation line, it will be required to have one additional pound per square inch of air pressure to unseat the valve member 22.

Also located upon the exterior surface of the body 14 is a second indicia in the form of a series of numerals and lines. The second indicia is divided into graduations of ten pounds per square inch of pressure (although the last digit, the zero has been omitted). As the cap 12 is screwed upon the body 14 and the forward surface of the cap 12 moves a total distance of one graduation to another graduation, that an additional pressure of ten pounds per square inch is required within the passage 18 in order to unseat the valve member 22. To acquire divisions of pressure of less then ten pounds per square inch, it is necessary to observe the indicia 38 which is in graduations of one pound per square inch. Therefore, the operator of the device 10 of this invention can, by rotating of the cap 12 with respect to the body 14, preselect the operating pressure of the device of this invention to within a single pound per square inch from values of one pound per square inch to one hundred and twenty pounds per square inch.

Upon the gas pressure within the passage 18 exceeding the preselected pressure level for the member 22, the member 22, as well as the spring retainer 26, is moved initially within the chamber 20 to the position shown in Figure 8 of the drawings. In this position, the pressurized gas within the passage 18, as well as in the forward portion of the chamber 22, is permitted to come into contact with the outer valve member 23 since a substantially increased area is exposed to the pressurized gas (entire forward surface of member 22 plus forward surface of member 23 as opposed to only the top of member 22), the members 22 and 23 now move with a "snap". As a result, pressurized gas is permitted to be quickly expelled to the ambient through the relief passage 40.

If the pressure within the passage 18 falls just slightly below the preselected pressure, the member 22 will again be reseated against the valve seat 24 thereby closing passage 18. Also, the outer valve member 23 will be reseated in contact with the portion of body 14 surrounding the passage 18. In this position, the tip of member 23 slightly deforms (or crushes) producing a leakage free seal. The pressure level established within the inflatable device (not shown) will be maintained at the desired level.

Another form of relief valve 10' is illustrated in Figure 12 in which cylindrical body 14' has a cylinrical extension 200 which contains the air passage 18'. The extension 200 is contained in a cylindrical sleeve 201 which is fitted into a cavity 203 in cover 102' and the end of the sleeve holds the outside edge of flexible diaphragm valve 204 against the bottom wall 203a of the cavity. The end of extension 200 is normally separated from valve 204 by space 205 and the end is reduced to form a chamber 206 which connects with port 207 in sleeve 201. The end of extension 200 opposite valve 204 forms a valve seat 208 surrounding the end port 209 for passage 18'. The opposite end of passage 18' has a valve seat 210 surrounding end port 211 of passage 18' and is formed by a circular groove 212 in the bottom wall 222 of cylindrical member 224. The port 107 is connected by passage 216 to cavity 217 downstream of a check valve 154' biased by spring 218 to normally close passage 150' which is connected with the top of cylinder 114. The passage 216 is drilled through cavity 217 and the drill hole is

closed by plug 216a.

A circular valve member 220 is supported at the end of a shaft 221 located in an opening in end 222 of cylinder 224 which is slidable in body 14'. The closed end 222 extends outwardly of the outside cylindrical edge of the valve 220 to provide a receiving chamber 223 and an additional area 222a which is subjected to pressure when the valve 220 is raised from the seat 210. The valve member 220 is normally held against seat 210 by a spring 28' which bears at one end against a ring 226 located on the closed end of cylinder 224. The other end of the spring is secured to an end retainer 227 which is threaded in an opening in cap 12'. The cap has internal threads 228 which co-act with threads 229 on the exterior of body 14' so that the cap 12' can be rotated and moved relative to the body 14' to adjust the bias force of the spring 28' on the valve member 220. The end of cylinder 224 adjacent end wall 222 normally covers ambient relief passage (port) 230 in body 14'. The zero setting of spring 28' is obtained by adjusting the amount retainer 227 is screwed into cap 12' and the rate of spring 28' is set by adjusting the amount that the spring is screwed into retainer 227. During rotation of cap 12', the end of spring 28' adjacent ring 226 is free to rotate.

When the valve member 220 is moved away from seat 210 by pressure in passage 18', air can enter the receiving chamber 223 and move cylinder 224 to connect passage 18' to atmosphere. As poreviously mentioned, when the valve 220 opens, the air pressure in chamber 223 acts on a much larger surface 22a of cylinder 224 and produces a greater force against the spring 28'. Thus, the cylinder moves with a "snap" action to open the passage 18' to atmosphere through port 230. Cover 102' contains a passage 232 which connects diaphragm valve 204 with the top end of the cylinder 114 so that the diaphragm valve is responsive to all times to pressure being produced ahead of the piston in the actuator.

The cap 12' has a circular beveled edge 36' which is divided into ten equal spaces around the complete circle by alternate indicia lines and numerals 234, and the valve body 14' has a series of indicia lines 235 along its surface which co-act with tapered edge 36' to indicate the pressure value at which the valve member 220 will open against the force of spring 28'. The indicia 235 are in 10 pound per square inch increments and one complete rotation of the cap 12' will move the edge 36' from one indicia 235 to the next indicia. Each indicia 234 changes the pressure setting by one pound per square inch.

The fitting (not shown) at the end of conduit 152' holds the valve of the inflatable object in open position so that check valve 154' keeps the air in the object during the suction stroke of the piston. After the cap 12' has been set to the selected pressure for the inflatable object, the foot lever 106 is repeatedly actuated to drive high pressure air passed the check valve 154' and through the conduit 152' into the object. At the same time, the high pressure air will act against diaphragm valve 204 and push it into the dashed line position against seat 208 in order to seal the passage 18' leading to valve member 220. Thus, during the time that piston 103 produces high pressure pulses in the passage 152', these pulses will be cut off from the valve 220 and will not cause air to be discharged through the ambient relief port 230. However, once the high pressure pumping ceases, the pressure in the inflatable object is communicated through passages 152' and 216 to spaces 206 and 205 and to the opposite side of the diaphragm valve, which causes the valve to straighten out and permits air to flow into the passage 18' and against valve member 220. Thus, the pressure in the passage 18' will be the same as in the inflatable object and therefore the pressure imparted to the object can be accurately controlled by the setting of the relief valve by spring 28'. Surges of high pressure developed by the piston which are higher in value than the desired air pressure of the inflated object will not interfere with the operation of valve 220.

Another form of the relief valve 10" is illustrated in Figure 13 and has the air passage 18" located in body 14". A check valve 250 in the form of a duck bill valve, is located in cavity 251 and a cylindrical lip separates cavity 251 from a cylindrical cavity 253. The check valve 250 has an upstream flange 250a which is located against a ring 254 which contains opening 150" communicating with the top of the cylinder 114. Also, the valve 250 has a cylindrical portion 250b connected with a tapered nozzle end 250c having a downstream opening 250d which is normally closed by air pressure in conduit 152" in order to prevent loss of air from the inflatable object. Normally, flange 250a is spaced from the end of lip 252 so that there is a communication space (passage) 255 between the cavity 251 and the cylindrical cavity 253, and passage 256 connects cavity 253 with passage 18". The passage 18" supported at the end wall 222 of cylindrical member 224. The structure of the relief valve for supporting the valve 220 for movement and for biasing the valve is identical to the corresponding structure in Figure 12 and carries the same reference numerals. The pressure at which the cylindrical member 224 opens the ambient relief port 230 is set by rotation of the cap 12' in the same manner as in Figure 12.

In the operation of the relief valve 10" of Figure 13, when the pressure at the top of the cylinder 114 is greater than the pressure in conduit 152" downstream of duck bill valve 250, the valve nozzle end will open and flange 250a will move to the dashed line position to close of the space 255 at the top of lip 252. Therefore, the passage 256 leading to passage 18" will be normally closed while air is delivered to the inflatable object. However, when the pressure in the top of the cylinder becomes less than in the inflatable object, the duck bill valve nozzle opening will close and flange 250a will be moved back against the ring 254, thereby opening passages 253 and 256 to permit the pressure in the inflatable object to communicate with valve member 220 through the passage 18".

Thus, the prior embodiments of Figures 12 and 13 serve to isolate the relief valve 10" from pressure pulses which exceed the pressure in the inflatable object so that a false discharge to atmosphere will

not result before the inflatable object has not reached the desired inflation pressure. It is apparent that various other types of valves could be utilized to accomplish the desired results and that other structures can be utilized to pivot the actuator to both the movable lever and to the base and to spring bias the cylinder to raise the lever. For instance, the actuator biasing spring could be placed about the pivot of the lever to the base instead of being placed around the piston rod.

CLAIMS

1. An air pump for inflating an inflatable object comprising: an actuator comprising a cylinder containing a piston; means for moving said piston to develop pressurized air within said cylinder; an output conduit connected with said cylinder for receiving air compressed by movement of said piston and delivering said air to said object; a check valve for said output conduit to prevent compressed air directed to said object from returning to said cylinder; a relief valve responsive to the pressure ahead of said piston and delivered to said object for selecting the valve of pressure developed in said object by said actuator; and means for adjusting said relief valve to preselect said pressure value; an air passage; a valve member in said relief valve responsive to the pressure in said air passage controlling the communication of said air passage with an ambient pressure passage; passage means for connecting said output conduit downstream of said check valve with said air passage; and valve means cooperating with said passage means and responsive to said pressure developed in said actuator for closing said valve means and said passage means when said actuator pressure exceeds the pressure in said output conduit downstream of said check valve corresponding to the pressure in said object.

2. The air pump as claimed in Claim 1, wherein said relief valve comprises: a valve seat at the end of said air passage, said valve member located adjacent said seat; and spring means for normally biasing said valve member against said seat to seal said air passage, said ambient pressure passage connected with said air passage upon movement of said valve member form said seat by air pressure in said air passage.

3. The air pump as claimed in Claim 2, including support means for mounting said valve means and providing an enlarged area subject to said air pressure after movement of said valve member away from said seat.

4. The air pump as claimed in Claim 3 wherein said adjusting means comprises means for adjusting the amount of biasing of said spring means against said valve member.

5. The air pump as claimed in Claim 1, wherein said check valve comprises: a flexible valve in said output conduit having a nozzle opening at its downstream end, and an end flange at its upstream end, the high pressure air received from the top of said cylinder passing through said nozzle opening to said outlet conduit, said flange being responsive to said actuator discharge pressure on one side and to said conduit pressure downstream of said nozzle on the other side; and port means for connecting said conduit downstream of said nozzle to said air passage and controlled by said flange, said flange being movable to close said port means when said discharge pressure exceeds the downstream conduit pressure.

6. An air pump for inflating an inflatable object, substantially as hereinbefore described, with reference to and as illustrated in the accompanying drawings.

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